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Knowledge gaps and climate adaptation policy: a comparative analysis of six Latin American countries

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ABSTRACT

This article identifies and analyzes some of the main knowledge gaps that affect the development of climate adaptation policies in the Latin American context. It is based on a comparative analysis of online survey results conducted among government officials working on climate adaptation in six countries of the region: Argentina, Brazil, Chile, Costa Rica, Paraguay and Uruguay. The article addresses four key issues. First, it identifies some of the critical knowledge deficits (missing or incomplete information) that affect climate adaptation policy making and implementation. Second, it addresses the obstacles and difficulties facing collaborative processes of knowledge production (co-production) between scientists and public policy actors. Third, it analyzes factors affecting knowledge uptake and use by policymakers. Finally, it identifies some of the main knowledge deficits specifically affecting the monitoring and assessment of climate adaptation policies and measures. Overall, the article provides a diagnosis of the main knowledge gaps facing climate adaptation policy in the Latin American countries studied. The results of this diagnosis can serve as input for a research and action agenda aiming to strength the interaction between science and policy on climate adaptation in Latin American countries.

Key policy insights

- The countries covered by the study suffer strong knowledge deficits related to the design, implementation and evaluation of adaptation policy.
- Collaborative modes of knowledge production in the field of climate adaptation do not tend to sustain over time. Climate change co-production processes tend to be project based, linked to specific initiatives rather than to institutionalized long-term policymaking or planning processes.
- The fragmentation and lack of integration of the knowledge available on the different aspects of climate adaptation issues deeply affect their usability in policy processes.
- Weak state capabilities to co-produce, manage and use knowledge in the policy process constitute a main barrier affecting the science-policy interface on climate adaptation issues.

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Climate change adaptation; knowledge co-production; science-policy interface; adaptation policy; Latin America

Introduction

Latin America is a region highly exposed and vulnerable to climate change. Floods, droughts, heat waves and other climate events are already affecting the region and generating strong social, economic and environmental impacts (Magrin et al., 2014). In this context, adaptation to climate change is steadily gaining more attention in

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the national and local public agenda across countries of the region and there is a slowly growing body of governmental policies and measures aiming to address climate adaptation issues (Magrin, 2015; UNEP, 2015). Furthermore, the nationally determined contributions (NDCs) submitted by countries of the region under the framework of the Paris Agreement include the development and implementation of climate adaptation strategies and policies (UNDP, 2016). However, the levels of complexity and uncertainty surrounding climate change adaptation issues raise difficult challenges to public policymaking processes and governmental structures (Mazzeo & Jacobi, 2016). In particular, climate adaptation highlights the complex relationships between science and public policy, and more broadly, between knowledge and decision making processes. The Working Group II contribution to the fifth Assessment Report of the Intergovernmental Panel on Climate Change -IPCC- (Klein et al., 2014) as well as the 2014 UNEP Adaptation Gap Report (UNEP, 2014) and others, underline that 'knowledge gaps' are some of the main obstacles or barriers that affect the planning and implementation of climate change adaptation measures. Following the UNEP report (2014), we use the term 'knowledge gaps' to refer not only to the lack of specific pieces of information but also to problems in the integration of different knowledge systems, and in the appropriation and use of knowledge for policy purposes.

This article aims to explore these issues in the Latin American context. It identifies and analyzes some of the main knowledge gaps that affect the development of climate adaptation policies in six countries of the region: Argentina, Brazil, Chile, Costa Rica, Paraguay and Uruguay. Specifically, the article addresses four key issues. First, it identifies some of the main information deficits, that is, missing or incomplete information that affects climate adaptation policymaking. Second, it addresses difficulties and obstacles faced by processes of knowledge co-production between researchers and policy actors. Third, it analyses the main factors affecting the uptake and use of available knowledge by policymakers working on climate adaptation. Finally, it explores knowledge deficits that affect evaluation and monitoring of adaptation policies. The article is mainly based on a comparative analysis of online survey results, conducted among public officials working on climate adaptation issues in the six countries encompassed by the study.

The identification and selection of these key issues was largely, although not exclusively, based on the UNEP Adaptation Gap Report 2014, which identifies three main types of knowledge gaps related to the production, integration, transfer and uptake of knowledge needed for adaptation. Our article also includes knowledge gaps in relation to the monitoring and evaluation of adaptation, which is an issue of increasing concern to the policy and research communities in the region, in the context of the implementation of the adaptation commitments included in the NDCs.

It is worth mentioning that this article results from *LatinoAdapta*, a regional research project on the interface between science and policy on climate adaptation issues, that is underway in the six Latin American countries mentioned above. The basic aim of the project is to strengthen the capacity of the national governments in those countries to develop evidence-based adaptation policies. Within this framework, the key issues addressed by the paper were jointly defined by the research teams involved in the project, from the six countries covered by the study.

It is important to make a couple of conceptual clarifications about the analysis. First, the study focuses on knowledge gaps in relation to public policies addressing climate adaptation issues. By public policies, we refer to authoritative decisions, actions or measures taken by governmental authorities in the exercise of their power (Theodoulou & Cahn, 1995). This focus on public policies delimits the scope of this research work and excludes from the analysis those climate adaptation decisions or measures taken by non-state actors, such as private sector or civil society initiatives, which are not linked to public policy measures.

Second, the analysis focuses on knowledge gaps affecting the policymaking or formulation stage as well as the implementation and evaluation phase of the policy cycle (Ripley, 1985). This broad approach to the public policy process is justified by the different levels of policy development in relation to climate change adaptation among the countries covered by the analysis. Furthermore, even within the same country, in many cases there are significant variations in the level of policy development among different sectors or levels of government. In this context, a broad approach to the public policy process allows these different levels of development of climate adaptation policy in the countries of the region to be taken into account, and the main information gaps and barriers affecting the adaptation policy process to be identified and analyzed.

The article is organized in three sections. First, it describes the theoretical framework and methodology used for the analysis. Then, it identifies and analyzes the research results in relation to each of the knowledge gap issues described in the introduction. Finally, the last section discusses the main conclusions and insights resulting from the analysis.

Method and data

As mentioned above, the article is mainly based on a comparative analysis of online survey results conducted in the six countries. The rationale of the survey questions was based on reviews of the literature on the interface between science and policy on climate adaptation, as well as on inputs from the *LatinoAdapta* local research teams based on their empirical knowledge at the country level.[1] We explain below the theoretical and empirical underpinning of the survey design in relation to each of the key knowledge gaps addressed by the study.

Theoretical bases of the survey instrument

Main knowledge deficits for climate adaptation policy

This section aims to identify some of the main deficits in the knowledge base affecting the development of climate adaptation policy in the countries covered by the research. By knowledge deficit, we refer not only to missing, but also to incomplete, information.

The knowledge needed for a specific adaptation policy or measure is highly contextual (UNEP, 2014). It can vary according to a variety of factors, especially spatial scale of the policy intervention (local, regional, national), specific geographical locations, substantive topics or sectors (water, health, agriculture, fisheries, etc.). This represents a challenge in designing a survey instrument for assessing this knowledge gap across six different countries and different adaptation policy issues.

To address this challenge, we identified eight broad categories of knowledge or type of information that cut across the adaptation policy agenda, regardless of the specific issue. Two of them were related to hard climate science (long-term climate projections, historical climate data), others referred to climate impacts, vulnerability assessments and gender, and the last three were related to different policy information and analysis issues (information about cost and benefits of different policy options; adaptation policy effectiveness; and funding). The identification and selection of categories was largely based on the UNEP Adaptation Gap Report 2014, especially its annex C (UNEP, 2014) as well as the chapter on Central and South America in the Working Group II contribution to the IPCC's fifth Assessment Report (Magrin et al., 2014).

The survey asks government officials to assess the relevance of knowledge deficits in relation to these eight categories or type of information. This question was supplemented by an open question in which respondents could identify other main gaps in the knowledge base affecting adaptation policy.

Main obstacles affecting knowledge co-production processes

Based on Bremer and Meisch´s (2017) classification of the different views of knowledge co-production, we address this issue from an *iterative interaction* perspective. In this approach, knowledge co-production processes are characterized by sustained and iterative interactions between researchers and stakeholders, centred on the production of usable knowledge for decision making and open to interdisciplinary approaches and also to other kinds of knowledge, e.g. practical knowledge, local communities and indigenous knowledge, etc. (Bremer & Meisch, 2017; Kirchhoff, Carmen Lemos, & Dessai, 2013; Lemos & Morehouse, 2005).

In this view, the normative appeal of co-production process in climate adaptation is based on the hypothesis, widely shared by the literature on collaborative and interactive models of science and policy interfaces (Funtowicz & Ravetz, 1993; Gibbons, 2000; Gibbons et al., 1994), that if knowledge is generated with the participation and involvement of relevant stakeholders, it is more likely that the knowledge produced will be relevant and useful for decision makers (Lemos et al., 2018; Ocampo-Melgar, Vicuña, Gironas, Varady, & Scott, 2016).

Based on this framework and inputs from the *LatinoAdapta* research teams, we identify six weakness or problems affecting co-production processes on climate adaptation to be assessed by the survey. These problems are (1) knowledge co-production do not sustain thought time; (2) relevant actors do not participate; (3)

knowledge needs of policy actors are not considered properly; (4) different disciplinary approaches are not considered; (5) knowledge resulting from co-production processes are (latter) not used in the policy process; and (6) there is not enough time and resources or proper coordination to develop co-production processes.

Problems 1–4 clearly refer to different constitutive elements of the ideal type of a knowledge co-production process as describe in the literature mentioned above. Problem 5 refers to the limited policy impacts of the knowledge co-production processes and problem 6 refers to some of the operational problems affecting this type of processes.

Main factors affecting the uptake and use of knowledge for climate adaptation policy

A widespread view within the literature is that one of the critical problems facing climate adaptation policies is not so much the lack of knowledge as such, but its limited appropriation and use by decision makers (Hanger, Pfenninger, Dreyfus, & Patt, 2013; UNEP, 2014) In other words, there is knowledge available, but it is not used. This raises the issue of the 'usability' of knowledge, particularly of scientific knowledge, for adaptation policy purposes (Kirchhoff et al., 2013; Lemos, Kirchhoff, & Ramprasad, 2012).

There is a large literature on the broad range of factors and conditions that can affect the uptake and use of knowledge in climate public policy and management processes (for instance, Archie, Dilling, Milford, & Pampel, 2014; Clar, Prutsch, & Steurer, 2013; Dilling & Lemos, 2011; Kemp et al., 2015; Letson et al., 2001; Tribbia & Moser, 2008). Furthermore, theoretical models have been developed to explain the interactions between these different factors and conditions. For example, Lemos et al. (2012) argue that usability is affected mainly by policymakers' perceptions of how knowledge meets their needs, the level and quality of interactions between knowledge users and producers, and how new knowledge interplays with other types of knowledge policymakers currently use.

While taking into account this rich theoretical background, the selection of the barriers for our analysis was mainly empirically driven. Based on the insights and knowledge of the cases from the *LatinoAdapta* local research teams, we identified seven factors or barriers that were considered relevant given the context of the countries covered by the project.

The first two factors refer to the understandability and accessibility of the available knowledge on climate adaptation. The third factor refers to the lack of downscaling of the available knowledge at the local or subnational level. Similarly, the fourth barrier refers to the lack of certainty of the available knowledge to justify specific policy choices, which is a common challenge faced by policymakers in the field of climate adaptation. The fifth factor refers to the fragmentation of the available knowledge related to climate adaptation issues and the sixth to the lack of proper knowledge transfer mechanisms and procedures between research and policy communities. Finally, the seventh factor refers to the capabilities of government agencies (technical and human capabilities and resources) to integrate and use the available knowledge in the policy process.

Main knowledge barriers affecting adaptation policy monitoring and assessment

There are a variety of barriers or factors that may hinder the monitoring and evaluation of climate adaptation policies (Clar et al., 2013). This analysis focuses specifically on knowledge related barriers. Based on a review of the literature and inputs from the *LatinoAdapta* local research teams, we identify six knowledge barriers to be assessed by the survey respondents.

The first three barriers or obstacles speak to some of the main conceptual and methodological difficulties facing the monitoring and evaluation of climate adaptation policies, and which are the object of increasing attention from the academic and policy communities alike (Berrang-Ford, Ford, & Paterson, 2011; Dupuis & Biesbroek, 2013; Ford et al., 2015; UNEP 2017; Vincent & Ofwona, 2018). These are (1) lack of clear delimitation of what an adaptation measure is; (2) lack of adequate mechanisms to monitor adaptation measure implementation; and (3) lack of clear indicators to assess the impact of adaptation measures.

The following two knowledge barrier refer to deficits or gaps in the knowledge needed for adaptation policy monitoring and evaluation, namely, (4) lack of a robust baseline upon which to assess the effects of adaptation measures; and (5) information needed for monitoring and evaluation is dispersed or not easily accessed. Finally, the last knowledge related barrier refers to (6) the lack of state capabilities to manage and use knowledge for policy monitoring and evaluation purposes.

The survey asks respondents to assess the different knowledge gaps on a simple 3-point- Likert type scale: very relevant, relevant, not relevant (plus the No Answer option). This format allows for assessing the relative intensity of the respondents' views in relation to each factor or issue. The survey was pretested on a group of qualified respondents to ensure questions and options were worded clearly and would be understandable to the respondents. The survey questions are available in the Supplemental Material.

Survey implementation

The online survey was aimed at government officials working on climate adaptation policy issues at the national or subnational levels, or in international negotiations. For the purposes of the survey, the term 'government official' was considered in a broad manner, to refer to any person working in the public sector, whether in an elected or politically appointed position, or as part of the state bureaucracy, whether in the executive, the legislative or a judicial branch of government. The survey included an initial set of screening questions, which allowed for the exclusion of those respondents who either did not work in the governmental sector, or whose governmental work was not related to climate adaptation issues.

Email communications, with the invitation to answer the online survey (and a link to the site), were emailed to individual public officials and specific governmental agencies or departments involved in climate adaptation issues in each country. A team of local researchers in each country was in charge of the identification of these potential respondents and the initial communication and distribution of the online survey, as well as the follow up communications. The involvement of these local research teams was a key factor enabling the targeting of the survey communications on those governmental officials and agencies directly working on climate adaptation issues in each of the six countries covered by the project.

The surveys were conducted using the SurveyMonkey® platform, from March to June 2018. The surveys were in Spanish and Portuguese (for Brazil) and the answers were anonymous.

In total, 277 public officials working on climate adaptation policy issues answered the survey entirely. There is some variation in the response rate between the countries. Costa Rica (71), Argentina (60) and Chile (49) are the countries with a higher level of responses, while Uruguay (38), Paraguay (32) and Brazil (27) had a lower level. The difference in response rate could be due to varying factors. In the case of Uruguay and Paraguay, the number of respondents might be related to a smaller climate adaptation policy community, given the size of the population and the state apparatus in these countries. Clearly, that cannot be the case for Brazil, which is the most populated country in Latin America, with an extensive state apparatus and a relatively well developed climate change policy and institutional framework (Jacobi et al., 2018: Viola & Franchini, 2014). In this case, the comparatively low number of responses might be related to the high level of political uncertainty and turmoil suffered by Brazil during 2018 (the survey was conducted during that year's first semester), which heavily affected the functioning of the government.

Given these variations, it is important to clarify that the article's analysis does not focus on aggregate regional survey results. Regional results could be distorted by the different number of responses from each country, affecting the validity of any inference regarding probable regional trends. Instead, the article is based on the comparison between the country survey results. In this way, the analysis can identify shared trends and patterns among countries covered by the project in order to highlight common challenges for a significant group of countries in the Latin American region.

Equally importantly, country surveys are not based on a probabilistic sampling and, therefore, their results do not pretend to be statistically representative. Notwithstanding this, it is worth stressing the targeted efforts made to reach public officials working on adaptation policy issues in each country and the reasonable level of response obtained for an online survey in most of the countries. All this speaks to the usefulness and relevance of the country survey results as the basis for a comparative analysis of the perceptions and views of government officials on the knowledge barriers and gaps that affect the development of climate adaptation policy in these Latin American countries.

In addition to the main data supplied by the survey results, the article is also based on national reports produced by the local research teams involved in the *LatinoAdapta* project. The national reports developed a more qualitative analysis and assessment of the four key knowledge gaps affecting climate adaptation policy in each

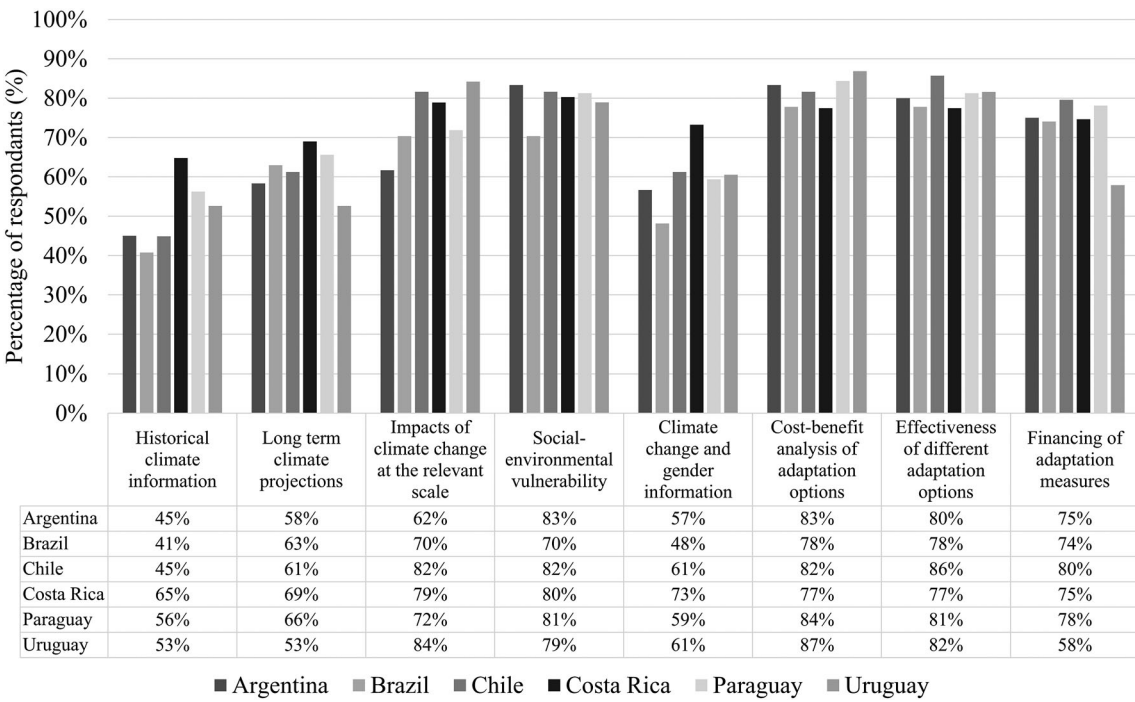
of the six countries covered by the project. The reports are mainly based on interviews with key actors, proceedings from policy-science dialogue workshops as well as on the survey results of each country. These reports are a subsidiary source of information for this comparative analysis.[2]

Results and analysis

Main knowledge deficits for climate adaptation policy processes

This section describe the survey results regarding the main knowledge deficits affecting the development of climate adaptation policy. To assess knowledge deficit, the survey asked public officials the following question: *What are the most relevant information gaps or deficits that affect the development of adaptation measures in your area of work?* In all of the six countries, the eight types of information listed by the survey were considered to bear relevant or very relevant deficits (see Figure 1).

However, there are significant variations in respondents' perceptions regarding the severity of those knowledge gaps. For instance, deficits of historical climatic information were considered relevant or very relevant by 41% to 54% of the respondents in five of the countries and 65% in Costa Rica. Similarly, deficits on long-term climate projections were considered relevant or very relevant by 52% to 66% of the public government respondents in five of the countries, with a slight increased rate in Costa Rica again (70%). Arguably, these are worrisome numbers; however, the rate of that response increases dramatically in relation to other categories of information. Around 80% of the government officials surveyed in all six countries considered that there were very relevant or relevant knowledge deficits in relation to the effectiveness of adaptation policies (i.e. how to assess effectiveness? what is an effective adaptation?), as well as regarding the costs and benefits of different adaptation policies and measures. Similarly, around 80% of the respondents in five of the countries, and slightly fewer in Brazil (71%), considered that there were relevant or very relevant information deficits on socio-environmental vulnerability, a key piece of information needed for adaptation policy making.



	Historical climate information	Long term climate projections	Impacts of climate change at the relevant scale	Social-environmental vulnerability	Climate change and gender information	Cost-benefit analysis of adaptation options	Effectiveness of different adaptation options	Financing of adaptation measures
Argentina	45%	58%	62%	83%	57%	83%	80%	75%
Brazil	41%	63%	70%	70%	48%	78%	78%	74%
Chile	45%	61%	82%	82%	61%	82%	86%	80%
Costa Rica	65%	69%	79%	80%	73%	77%	77%	75%
Paraguay	56%	66%	72%	81%	59%	84%	81%	78%
Uruguay	53%	53%	84%	79%	61%	87%	82%	58%

Figure 1. Relevant / very relevant knowledge deficits affecting adaptation policy.

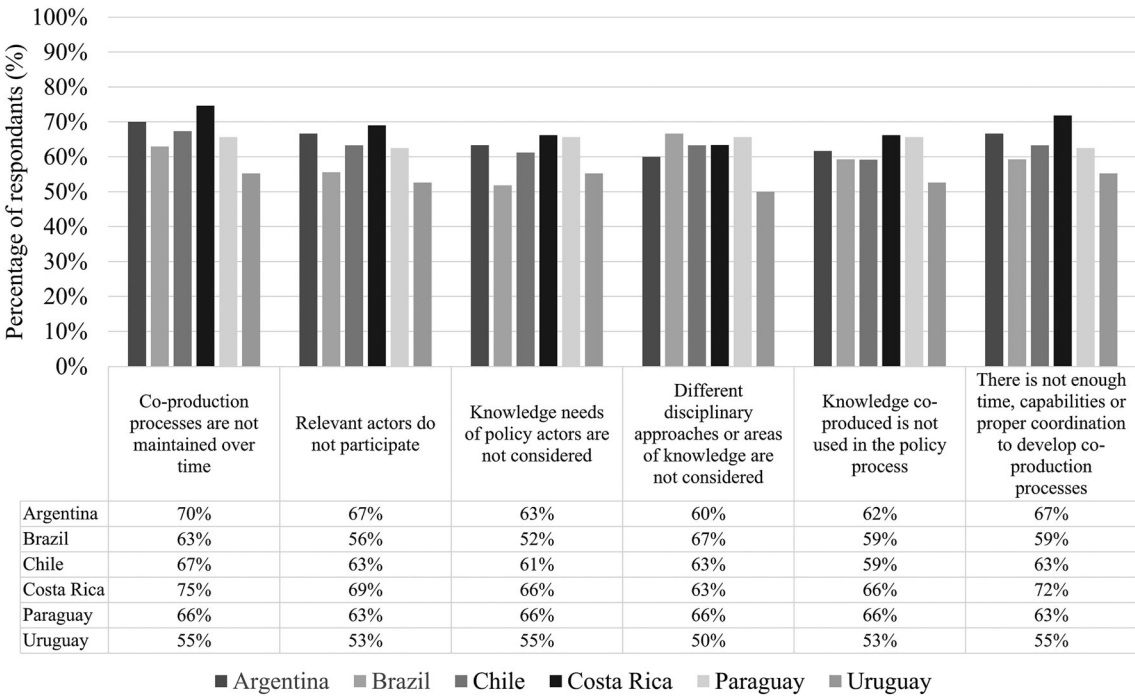
It is worth recalling, however, that these are nationally aggregated results. There might be important variations in the relevance of knowledge deficits depending on the specific issue at stake. In other words, knowledge deficits that are not very relevant according to the aggregated national results might be highly relevant for a specific issue, sector or subnational region. In this regard, the survey results do not allow for identifying the knowledge gaps in relation to each issue or sector; instead, they provide a general diagnosis of the main deficits in the available knowledge base that affect the development of adaptation policy in each of the countries covered by the study.

Main obstacles affecting knowledge co-production processes

The results of the online survey show that a very high percentage of public officials surveyed in all six countries had been involved in knowledge co-production processes related to climate change issues. From 85% of the public officials surveyed in Brazil, to 65% in Uruguay (the lowest percentage among the six counties), indicated that they have participated in climate knowledge production processes involving actors from different sectors (government, business, civil society, academy). Arguably, this is a very auspicious fact, taking into account that the survey specifically targeted government officials who are working on adaptation issues in different areas and levels of the countries studied.

However, the survey results also indicate the strong weaknesses suffered by these co-production processes. When answering the question: '*What difficulties do co-production processes face in order to generate relevant and useful knowledge for climate adaptation policy?*', the six categories of problems / obstacles listed in the survey were considered relevant or very relevant by at least 50% of respondents who participated in co-production processes in all six countries (see Figure 2).

Although all six categories of obstacles received a high assessment, there is one obstacle in particular that stands out from the comparative analysis of the country surveys as well as from the national *LatinoAdapta* reports. In all six countries, the majority of government officials surveyed considered that knowledge co-production processes on climate issues do not sustain over time. Furthermore, this obstacle was considered as



	Co-production processes are not maintained over time	Relevant actors do not participate	Knowledge needs of policy actors are not considered	Different disciplinary approaches or areas of knowledge are not considered	Knowledge co-produced is not used in the policy process	There is not enough time, capabilities or proper coordination to develop co-production processes
Argentina	70%	67%	63%	60%	62%	67%
Brazil	63%	56%	52%	67%	59%	59%
Chile	67%	63%	61%	63%	59%	63%
Costa Rica	75%	69%	66%	63%	66%	72%
Paraguay	66%	63%	66%	66%	66%	63%
Uruguay	55%	53%	55%	50%	53%	55%

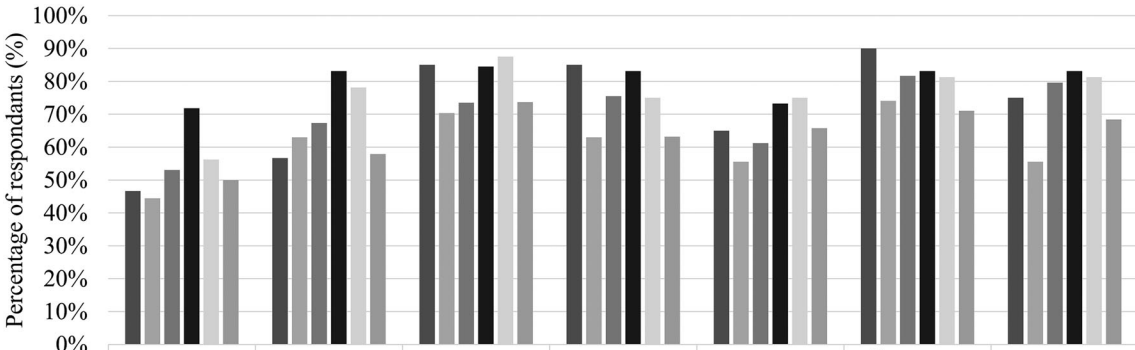
Figure 2. Relevant / very relevant obstacles affecting knowledge co-production processes for adaptation policy.

very relevant by the largest number of government officials surveyed in five of the six countries (Argentina, Brazil, Costa Rica, Paraguay and Uruguay), with a slightly lower result in Chile.

It is not the purpose of this article to search for explanations for the identified knowledge gaps or barriers. However, a relatively common pattern that emerges from the *LatinoAdapta* national reports is that many knowledge co-generation processes on climate change in the countries analyzed tend to be project based, and linked to specific initiatives rather than to institutionalized long-term policymaking or planning processes. The elaboration of national communications (country reports) under the UN Framework Convention on Climate Change (UNFCCC) is a good example of this dynamic. In many of the countries studied, the elaboration of the national communications have usually given rise to climate knowledge co-creation processes; however, these processes were mainly defined, financed and developed according to the specific needs and timeframes of the national communications (see, for instance, the Argentina *LatinoAdapta* report; Ryan, Scardamaglia, & Canziani, 2018).

Main factors affecting the uptake and use of knowledge for climate adaptation policy

The analysis of the country survey results allows the exploration of the factors and conditions hindering the appropriation and use of knowledge for adaptation policy purposes in the Latin American context. The survey asked public officials: *Which are the most important factors that affect the use of available information on climate change in your work on adaptation issues?* Although there are some significant variations between public officials' responses from the six countries, two common obstacles stand out. First, knowledge available for climate adaptation policymaking (climate data, impacts studies, social-environmental vulnerability assessments, etc.) is perceived as fragmented and dispersed. A large number of the government officials surveyed considered that this is a relevant or very relevant obstacle affecting the uptake and use of available knowledge for adaptation policy making. This assessment was shared by 88% of public officials surveyed in Paraguay, 85% in Argentina and Costa Rica, 74% in Chile, 73% in Uruguay and 70% in Brazil (see Figure 3). Beyond the different institutional and political contexts, these figures show a strong, shared perception among public officials from



	Scientific information is difficult to understand	Scientific information is not easily accessible	Information is fragmented	Information is not disaggregated at the local level	The level of certainty of information is insufficient to justify adaptation policies	Government agencies lack resources to analyze and evaluate available information	Knowledge transfer mechanisms are inadequate
Argentina	47%	57%	85%	85%	65%	90%	75%
Brazil	44%	63%	70%	63%	56%	74%	56%
Chile	53%	67%	73%	76%	61%	82%	80%
Costa Rica	72%	83%	85%	83%	73%	83%	83%
Paraguay	56%	78%	88%	75%	75%	81%	81%
Uruguay	50%	58%	74%	63%	66%	71%	68%

Figure 3. Relevant / very relevant factors affecting the uptake and use of knowledge for adaptation policy.

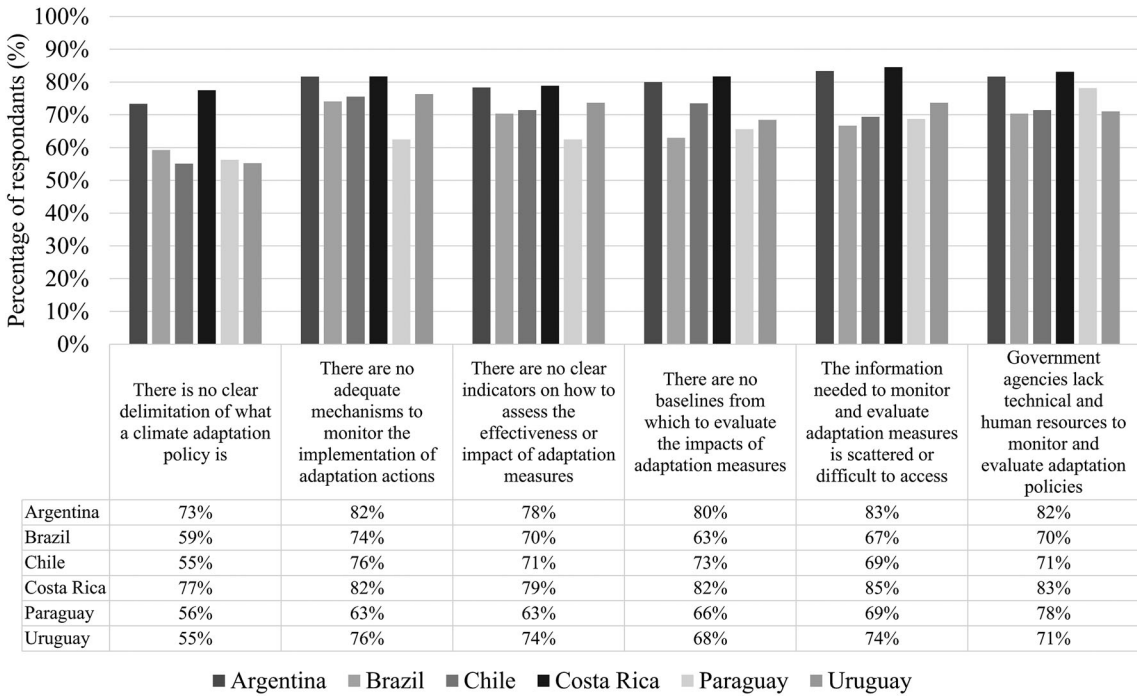
these six countries about the relevance of the knowledge fragmentation problem in climate adaptation policy making.

Another common problem that stand out from the comparative analysis of the countries surveys is weak state capabilities. Governmental agencies and departments working on climate adaptation policy do not have enough human and technical capabilities to analyse and assess the available information. Weak state capacity was considered a very relevant or relevant factor affecting the usability of available knowledge for adaptation policymaking and implementation by an overwhelming majority of the public officials surveyed, in all six countries: 90% in Argentina, 83% in Costa Rica, 81% in Chile and Paraguay, 74% in Brazil and 71% in Uruguay (see Figure 3). Prior work has already stressed the relevance of state capacity issues for the development and implementation of climate policy in the Latin American context (Fernández Bremauntz, 2012; Magrin, 2015; Ryan, 2017). These survey results clearly show that weak state capacity is also a relevant factor affecting the uptake and use of knowledge in adaptation policy processes.

Main knowledge barriers affecting adaptation policy monitoring and assessment

When faced with the question: *what are the main knowledge barriers or deficits that arise in the monitoring and evaluation of adaptation policies or adaptation measures in your area of work?,* the six types of barriers listed by the survey were considered relevant or very relevant by over 50% of the public officials, in all the countries covered by the project. This result speaks to an overall, serious knowledge gap situation affecting adaptation policy assessment and monitoring in Latin America.

Within this context, our analysis focuses on two key knowledge barriers that stand out from the comparative analysis of country surveys and of the *LatinoAdapta* national reports. In the first place, weak state capabilities (again) are perceived to be a main barrier affecting the assessment and monitoring of climate adaptation policy. 83% of the public officials surveyed in Argentina and Costa Rica, 78% in Paraguay, 71% in Chile and Uruguay and 70% in Brazil, stated that governmental agencies working on climate adaptation issues lack the



	There is no clear delimitation of what a climate adaptation policy is	There are no adequate mechanisms to monitor the implementation of adaptation actions	There are no clear indicators on how to assess the effectiveness or impact of adaptation measures	There are no baselines from which to evaluate the impacts of adaptation measures	The information needed to monitor and evaluate adaptation measures is scattered or difficult to access	Government agencies lack technical and human resources to monitor and evaluate adaptation policies
Argentina	73%	82%	78%	80%	83%	82%
Brazil	59%	74%	70%	63%	67%	70%
Chile	55%	76%	71%	73%	69%	71%
Costa Rica	77%	82%	79%	82%	85%	83%
Paraguay	56%	63%	63%	66%	69%	78%
Uruguay	55%	76%	74%	68%	74%	71%

Figure 4. Relevant / very relevant knowledge barriers affecting monitoring and evaluation of adaptation policy.

technical capabilities and skilled human resources needed to monitor and assess the implementation of climate adaptation policies and measures (see Figure 4). Furthermore, in four out of the six countries surveyed (Argentina, Chile, Costa Rica and Paraguay), it was considered as a *very* relevant knowledge obstacle by the largest number of government officials.

A second set of knowledge barriers that stand out, refers to the lack of clear conceptual and methodological frameworks to monitor and evaluate climate adaptation policy. Over 70% of the government officials surveyed in five of the countries (with a slightly lower rate of response in Paraguay, 63%) considered that there are no clear indicators about how to assess the impact or effectiveness of adaptation measures. Not surprisingly, a similar number of government officials stated that there are no adequate mechanisms to monitor the progress of adaptation policies and measures. Both aspects are conceptually deeply interrelated. Several researchers argue that many of the practical difficulties in monitoring progress and assessing adaptation policy effectiveness are linked to the conceptual difficulties in defining when adaptation has taken place (Dupuis & Biesbroek, 2013; Vincent & Ofwona, 2018). In this regard, it is interesting to note that 55% of the public officials surveyed in Uruguay and Chile, 56% in Paraguay, 59% in Brazil, 73% in Argentina and 77% in Costa Rica considered that there are not clear delimitations of what should be considered as a climate adaptation policy or measure. Despite the variation between the countries' rate of response, it is significant that a majority of the government officials surveyed, working on adaptation policy issues, in all of the six countries, acknowledge that they face conceptual difficulties in defining what adaptation policy is. Arguably, this conceptual difficulty is at the base of the problem of designing indicators and mechanisms to monitor and assess adaptation policy progress.

Conclusions

This article has explored the perceptions and views of government officials working on climate adaptation regarding the main knowledge gaps that affect the development of adaptation policy in Latin American countries. This final section highlights four main findings resulting from this comparative analysis and makes some suggestions for a future research agenda in this area.

First, there are strong knowledge gaps on issues that are directly related to the field of policy studies and analysis. Issues such as effectiveness indicators for adaptation measures, mechanisms to track adaptation progress, and costs and benefits of different adaptation alternatives are clear examples of this type of knowledge deficit faced by government officials across the six Latin American countries covered by the analysis. To a certain extent, these deficits are not surprising. Literature reviews on climate change, policy and decision making in Latin America (Locatelli et al., 2017; Ryan & Ramírez Cuesta, 2016) show a relatively low level of attention to these issues by those scientific disciplines and fields whose purpose is, precisely, to study decision making process (political science, public policy, economy, sociology, etc.). Although it can be argued that there is a changing trend in the region, and social sciences and policy studies are gradually increasing their attention to climate change issues, the survey results show that there are still clear knowledge gaps related to the design, implementation and evaluation of adaptation policy. This clearly represents a challenge, but also an opportunity, for the policy studies research community in the region, in a context in which governments must take action to implement the climate adaptation objectives and policies committed in their NDCs to the Paris Agreement.

Second, in relation to collaborative modes of knowledge production, the results of the analysis stress the lack of sustainability of co-production processes over time. Arguably, this speaks to the low level of institutionalization suffered by knowledge co-production processes in the field of climate adaptation in many Latin American countries. As mentioned above, co-production processes on climate change issues tend to be project based, and linked to specific initiatives rather than to institutionalized long-term policymaking or planning processes.

The lack of continuity of knowledge co-creation processes over time also affects the possibility of generating and sustaining long-term relationships between research and policy communities working on climate adaptation issues. In the literature on the science and policy interface, several authors argue that the level and quality of the interaction between researchers and policymakers is one of the key factors in strengthening the relationship between science and policy (Court & Young, 2003; De Pinto, Loboguerrero, Londoño, Ovalle Sanabria, & Suarez Castaño, 2018; Lemos et al., 2012). Issues of trust, legitimacy, better communication and mutual understanding of the needs and contexts in which each actor operates, depend in part on the

development of shared venues between academic and policy actors, and long-term collaborative processes. In this direction, many of the *LatinoAdapta* national reports strongly emphasized this need to generate and sustain spaces for dialogue between science and policy in the countries covered by the study (see, for instance, the case of Uruguay; Rosas et al., 2018).

Third, in relation to the factors affecting the use of available knowledge for policy purposes, the results of the analysis stress the problems of knowledge fragmentation. As mentioned above, there is a strong, shared perception among public officials from the six countries that the lack of integration of the knowledge available on different aspects of a particular climate adaptation issue (climate data, impacts, socio-environmental vulnerability assessments, economic analysis, etc.) deeply affects their usability in policymaking process. Arguably, the fragmentation problem highlights the role, and need, for boundary institutions, mechanisms and actors that can act as translators and integrators of the different types of knowledge available in order to strengthen adaptation policymaking and management (Gustafsson & Lidskog, 2018; Kirchhoff et al., 2013). Clearly, in this situation, the study and analysis of the dynamics, functioning and impacts of boundary institutions and mechanisms in the Latin American political and institutional context, becomes a key element of a regional research agenda on science and policy on climate adaptation issues.

Finally, weak state capabilities emerge as a main factor affecting the science-policy interface in the countries of the region. State capacity is a multidimensional concept, which refers and encompasses different types of capabilities and resources needed by the state to intervene in public affairs (Asinelli & Acuña, 2015). In this article, the analysis has focused on those state capabilities more directly related to the production, management and use of knowledge in the adaptation policy process. In this regard, the results of several of the survey questions indicate that government agencies' lack of sufficient and skilled human and technical resources is a critical factor that seriously affects the state's capacity to manage and use knowledge for climate adaptation policy. Problems of coordination and articulation between different levels and areas of government add an even greater dose of complexity to the processes of co-production and use of knowledge in adaptation policymaking. Furthermore, as pointed out in several of the *LatinoAdapta* national reports, these types of state capacity problems tend to be even more pronounced in the case of subnational governments, particularly at the municipal or local level (Bustos, Marinkovic, Harris, & Salas, 2018; Jacobi et al., 2018; Lima Morra, Centurión, Speranza, & de Arias, 2018; Morales, 2018; Ryan et al., 2018). This is a critical aspect, given that adaptation policies generally have clear territorial anchors and many key issues of the adaptation agenda usually fall within subnational and local governments' competence, like land-use planning, urban infrastructure development and water management. In short, in the Latin American context, weak state capabilities to co-produce, manage and use knowledge in the policy process constitute a main barrier affecting the science-policy interface on climate adaptation issues.

Notes

1. The local research teams were formed by researchers belonging to universities and research centres of each of the countries involved in the *LatinoAdapta* project.
2. The full six reports are available at https://www.cambioclimaticoydecisiones.org/proyecto-latinoadapta/diagnosticos-naciones/.

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